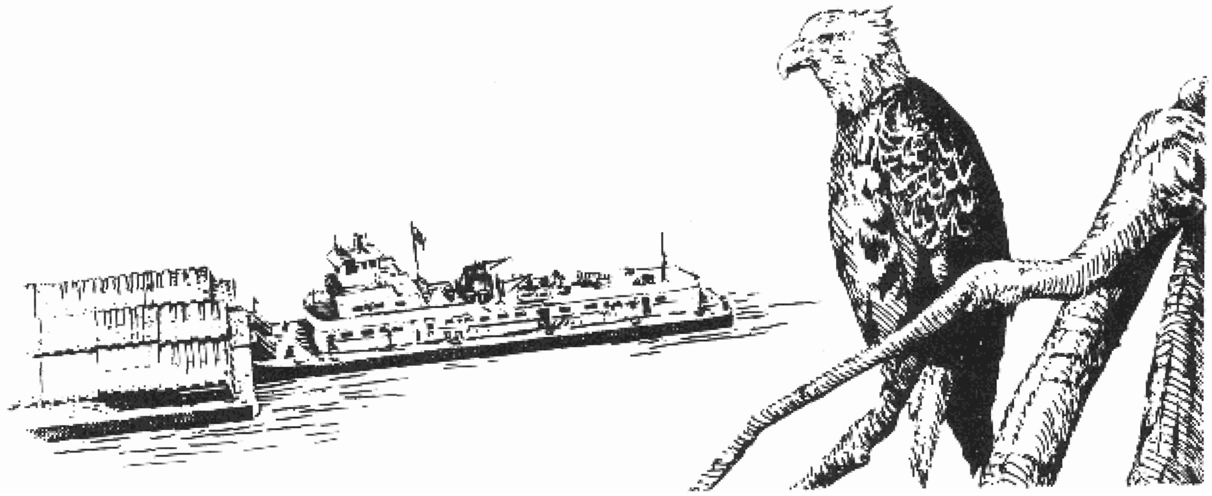
Chapter 11

High Water, Low Water



The river belongs to the nation,
The levee, they say, to the state;
The government runs navigation,
The commonwealth, though pays the freight.
Now, here is the problem that's heavy —
Please which is the right or the wrong?
When the water runs over the levee,
To whom does the river belong?
— Anonymous[1]

Floods, or freshets aa the 19th century population of the Mississippi Valley liked to call them, have been a perennial problem. On the lower river such floods, carrying water from tributaries that form a drainage basin stretching from Glacier National Park in Montana to northern New York, once overflowed natural levees left by silt from the flooding river into thousands of acres of lowlands. To prevent flooding there, natural levees were raised. Along the Mississippi north of St. Louis, however, the problem is different. Hare both farm land and towns lie squeezed in narrow strips of bottom land which end abruptly with high bluffs. There is no wide flood plain to spread the water out. Towns and farms "on the hill" are safe in even the worst flood, but the parts of toms which border the Upper

Mississippi are often in some danger even after a good rain, and they are particularly vulnerable to a major flood.

For some reason, floods dong; the Mississippi River seem to have come in cycles or "wet decades," Periods of high water seem to alternate with years of unusually low water. Wet decades occurred in the 1820's, the 1840's, the 1880's and the 1940's. The most recent wet cycle began in the mid-1960's and continued into the early 1970's. In this last wet cycle, two of the worst floods on record have occurred.

Floods along the Upper Mississippi, while different from the spread-out shallow floods of the lower river, are also quite different from the spectacular gully washers of the Western states or the floods along deep narrow valleys or canyons such as that at Rapid City, South Dakota, in 1972. Those dramatic f l d s can splinter trees and wrap cars into knots.

A Mississippi flood is comparatively quieter and more ponderous. Weeks ahead of time the Weather Bureau, with the assistance of the Corps of Engineers, is able to predict with fair accuracy the probability of a flood by observing the amount of ground water left from the previous summer and fall, the snow cover, and other such measurements of available water. Days ahead of time, as the weather pattern becomes clearer, they can predict the seriousness of the flood and also, within hours, exactly when the crest will pass any given town along the river. More often than not they are within inches of the correct flood stage. Newspapers, radio, and television follow the crest down the river, and 33 it arrives at each of the towns it becomes a social went. Townspeople turn out along the waterfront to watch the water slowly inch up the street.

This deliberateness makes a Mississippi flood seem different from other natural disasters, Tornados and blizzards show their violence, but a flood hides its destruction under a disarmingly calm surface. The currant eating away a foundation is not so visible, and It becomes hard for observers to imagine that millions of dollars of damage are being done while children ride bicycles dawn streets covered by inches of water.

But the leisurely pace of the flood is deceptive. Bit by bit foundations crumble, water supplies are contaminated, belongings ruined, farmlands made useless for the coming season. A3 the flood wears on time is lost at factories, roads wash out and buckle. Far those directly involved, and indirectly for every taxpayer, a flood is expensive — more expensive each year as populations and industry increase along the river, and, against strong advice, encroach onto the flood plains.

Early Flood Control Work. Combating floods was at first, left in the hands of individual residents. South of the Ohio River early in the 19th century, owners of land along the river's edge were responsible for constructing and maintaining levees along their own portion of land, putting all the burden on them and none on landowners further inland, who benefitted as much as property owners along the river. When this practice eventually proved unworkable, the concept of levee districts developed. These districts included all threatened residents within an area which could be protected by a single levee. Residents in towns further north built their houses on stilts, sought high ground, or, if they were true river rats, lived with nature, expecting to have to move furniture up to the second floor every few years.

In spite of the need for more systematic national flood control planning, the Corps of Engineers did not become involved in flood control in a major way until the Flood Control Act of 1936 put the responsibility for such control with the Engineers.'

Prim to this such flood control as the Rock Island District engaged in was piecemeal and often disguised as "navigation improvement." The Corps had on occasion aided flood victims, as in the spring of 1882 during the disastrous floods south of St. Louis when the *Barnard* and the *Coal Bluff*, dong with District personnel, went south with supplies. Even this emergency relief, however, needed to be authorized by a Congressional resolution Primarily, the Corps remained limited to it3 single-purpose navigation projects,

The first official departure from single-purpose navigation projects came in 1879 when Congress established the Mississippi River Commission. The Commission consisted of seven members: three appointed from the Corps of Engineers (one of whom was to serve as president), three from civilian life, and one from the United States Coast and Geodetic Survey. In the Act of June 28, 1879, establishing the Commission, Congress directed that they survey the river and develop plans which would "correct, permanently locate, and deepen the channel and protect the banks of the Mississippi River; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade and the postal service."[3] Further, Congress gave the Commission power to initiate plans. In spite of these broad directives, however, "aid to navigation" remained the official justification for projects until the Flood Control Act of 1917 specifically authorized flood control on the Mississippi and Sacramento Rivers.

Originally the Commission's jurisdiction ever surveys and investigations extended to the headwaters of the Mississippi, while jurisdiction for construction work was limited to the Lower Mississippi from the mouth of the Ohio River to the Head of the Passes. Its Jurisdiction was extended from time to time until by 1926 it had control over construction of flood control works on the main river to Rock Island, and on the tributaries far as far up as they influenced f l d s on the Mississippi.[4] All of the construction work supervised by the Commission was detailed to the Corps of Engineers.

For the most part, however, the Mississippi River Commission concentrated ita efforts south of the Ohio River. It did investigate the possibility of using reservoirs on the Upper Mississippi tributaries as a means of flood control, and had they determined on this method of improvement, the Rock

Island District might have been in the flood control business much earlier. However, the Commission rejected reservoirs a3 too expensive and decided on levees as the primary method of fighting floods.

In the early *years* of improvement work, the Rock Island District took it3 limitation to navigation problems seriously. In 1884 people in the Sny Drainage District south of Quincy, Illinois, who had built a 50-mile levee requested, reimbursement from the Government on grounds that the levee aided navigation by keeping the water within the channel. Colonel Mackenzie was requested to examine this levee to determine if it qualified, and on the basis of his report that the levee neither helped nor hurt navigation, the request was denied.[5]

Within 10 years, however, the increasing encroachment of the river bottoms by agriculture, industry and population heightened the need for flood control. Both the Corps and Congress softened their positions, and in 1895 the Rock Island District embarked on its first project which dearly included flmd control as well a3 navigation improvement as it3 purpose: the Flint Creek Levee.

The River and Harbor Act of August 18, 1894, provided for a survey along the west side of the Mississippi River from Flint Creek to the Iowa River "with a v i m to improving the navigation by preventing the water from overflowing the natural and artificial banks along those parts of the river and deepening the channel."[6] The same act directed Colonel Mackenzie to make a survey of existing levees between Warsaw and Quincy, Illinois, Here a series of three levees; comprised the Hunt, Lima Lake, and Indian Grave drainage districts built between 1881 and 1888. Recent f l d s had seriously weakened and breached these levees, and disagreements between levee commissioners had allowed further deterioration,

Over the next two decades the justification of levees as navigation improvements was used again and again in Congressional directives to the Corps of Engineers, though it was evident that in water high enough to flood, no levee was needed to deepen the channel for boats.

In 1895 Congress appropriated $85,000 to repair and raise the levee from Quincy to Warsaw three feet above the high water of 1892. The same act appropriated $300,000 t , construct a 35-mile levee between Flint Creek and the Iowa River. This was an earth levee with a slope of 3 to 1 on the river side and 2 to 1 on the land side, with a 4-foot width at the crown. The Flint Creek Levee was not only the first one constructed by the Rock Island District, it was also the last one built without cost-sharing by local interests.[7]

The levees at Flint Creek and Quincy were simply constructed of earth removed from borrow pits on both river and land sides of the levee. The borrow pita were located beyond a 20-foot shelf on which the bvee sat, but within the 100-foot strip of land owned by the lave district. Levees averaged 7 feet high. Where they were subjected to the action of current or waves they were revetted; elsewhere grass and weeds made a thick mat. The only equipment used in the construction of these levees was a scraper.

More complicated problems arose over drainage of water impounded behind the levees when the river reached flood stage. This was not a serious problem in 1895, however, since both of the levees were in rural areas; it was handled by the installation of holding ponds and pumping stations.

Following these two levee projects, the Rock Island District did very little levee work for the next 30 years, aside from a minimum amount of work on drainage problems caused by the pool behind the Keokuk Power Darn. Not until the disastrous flood of 1927 did the Corps become active in outright flood control projects.

The 1927 flood dramatized the Engineers' inadequate program of Improving navigation on the main streams while overlooking the impact of the tributaries. An argument had been building among various groups over the best method for dealing with floods. Some groups wanted levees, others wanted dams, yet others wanted reservoirs. Out of thia confusion, and based on cost estimates for comprehensive surveys which Congress requested of the Corps in 1925, grew the River and Harbor Bill of 1927 in which Congress authorized comprehensive examinations and surveys of the inland waterways by the Corps of Engineers in order to formulate

> general plans fat the most effective improvement of navigable streams and their tributaries for the purpose of navigation and the prosecution of such improvement in combination with the most efficient development of the potential water power, the control of floods, and the needs of irrigation.[8]

These were the famous "308 reports," so called because the reports submitted by the Corps were printed as House Document 308, which became the point of departure for most basin-wide, multipurpose water resources planning in the United States. The Tennessee Valley Authority Act of 1933 made that the pilot basin based on these *surveys.*

Following the 1927 flood, the Mississippi River Commission requested the Rock Island District to assist with levee rehabilitation as far north a3 Rock Island. These were the first flood control projects in the District which did not come under the guise of "navigation improvement."

The Flood Control Act of June 22, 1936, put flood control more definitely under the supervision of the Corps of Engineers. This act is usually considered the beginning of full-fledged flood protection work by the Corps. The same act put, responsibility for water flow retardation and soil erosion prevention under the Soil Conservation Service of the Department of Apiculture,

The Flood Control Act of 1936 authorized 14 individual flood control projects in the Rack Island District. Most of these were in agricultural drainage districts downstream from Rock Island, and included work at Keithsburg, Henderson, South Quincy, the Sny Island Levee District, and the Rock River

Basin. Congress did not authorize money for thew projects, however, and no actual work was done in 1936.

A3 another provision of the 1936 act, Congress formally adopted benefit-cost analysis as a means of determining feasibility, although this had long been an informal policy for earlier Engineer projects. Section 1 of the act stated:

> The Federal Government should improve or participate in the improvement of navigable waters or their tributaries, including watersheds thereof, for flood control purposes if the benefits to whosoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected.[9]

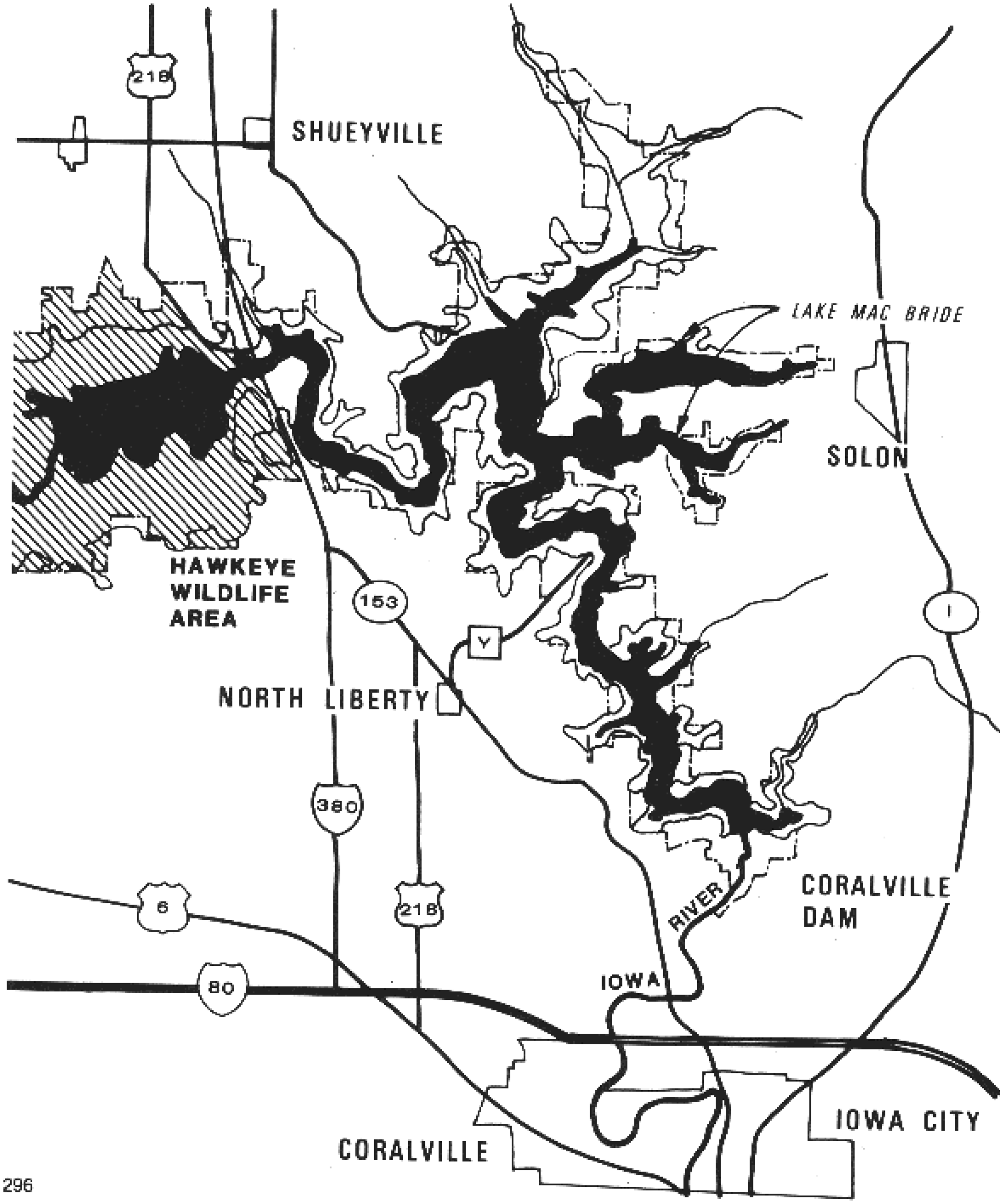
Little work was done in the next, two years, with only $4,000 worth of work in the District to 1938, but with the Flood Control Act of 1958, flmd protection was on its way to becoming the main activity of the Rock Island District. That act included the first provisions for Coralville Reservoir.

Reservoirs. The idea of controlling the flow of the Mississippi River by a series of reservoirs to impound excess water from spring floods and snow melt was a recurring idea since the 1850's when Abbott and Humphreys investigated that possibility as part of their hydrographic survey. In 1868 Major G. K. Warren, as part of hi3 examination of the Upper Mississippi and its tributaries suggested a reservoir system at the headwaters of the Mississippi, not to control floods, but to increase the flow of the river between Minneapolis and Lake Pepin during the low water season. His 1870 report expanded this recommendation to 41 reservoirs on the St. Croix, Chippewa, and Wisconsin Rivera, as well as on the Mississippi.[10] Humphreys, however, continued to oppose reservoirs, and hi3 successors followed him in considering them either too expensive or of little value to control flooding. Eventually, between 1881 and 1895, five reservoirs were constructed on the Mississippi headwaters in northern Minnesota, and a sixth was added in 1913. While they were partially successful in aiding navigation for 40 or 50 miles downstream, they aided even more the milling interests in Minneapolis who used waterpower to run their mills.

If the main stem of the Mississippi had been the major cause of flooding north of St. Louis, perhaps reservoirs would have remained too expensive and impractical, but flooding in the Upper Midwest came as much from the tributaries as from the Mississippi. The Rock, Iowa, and Des Moines Rivers were capable of causing extensive flood damage to towns along their own banks before swelling the main river with their flood waters. Further, low water was even more of a problem on these rivers than on the Mississippi. On the main river, low water hindered navigation, but low water on rivers such as the Des Moines reduced the water flow so much as to affect water quality for those towns which took their water supply from the river. Low water also adversely affected fish and wildlife and reduced both industrid and recreational uae of the stream. On such streams, reservoirs would be of benefit as much during low water as during flds,

In a comprehensive plan for flood control, the Flood Control Act of 1938 authorized $2,700,000 for local flood protection an the Mississippi and Illinois Rivers, and $6,000,000 for reservoirs. The act specifically made provisions for a reservoir at Coralville on the Iowa River just north of Iowa City, as one of the projects selected and approved by the Chief of Engineers. The estimated cost was $4,999,000.

Extensive field surveys began at a tentative site in 1939 to determine land damages and remedial work which would be required, and to collect data for general hydraulic, hydrological, economic and flood routing studies, District engineers drew the first plans during 1940, which provided for construction of an earth fill dam, 1,400 feet long at the top, rising approximately 95 feet above the stream bed, with a reservoir providing for controlled storage of 4120,000 acre-feet. An outlet works was to be located adjacent to the left abutment, with a controlled spillway on the right abutment. Discharge from the spillway (which would occur only during extreme flooding) reentered the river 900 feet downstream from the toe of the dam. In fiscal 1940, $146,163 was spent on the project.[11]


218
SHUEYVILLE
LAKE MAC BRIDE
SOLON
HAWKEYE
WILDLIFE
AREA
153
Y
NORTH LIBERTY
1
380
CORALVILLE
DAM
RIVER
6
218
IOWA
80
IOWA CITY
CORALVILLE

A map of the extensive Coralville Reservoir project, first of the flood control reservoirs constructed by the Rock Island District.

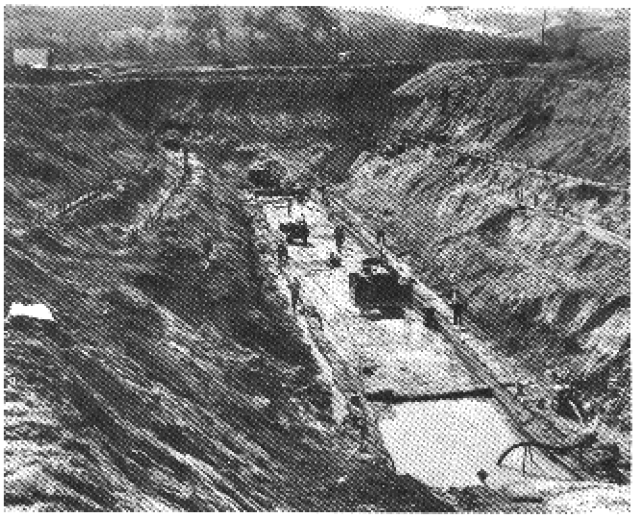
World War II brought civil works in the District to a standstill before any actual construction had begun at Coralville. Throughout the war only minor attention was paid to the project. In 1944 engineers considered alternate sites; in 1945 $29,000 was spent for surveys and reports (the largest single item of any Civil project in the District in 1945). By the time construction began in 1948, the revised cost estimate had reached $14,089,000.

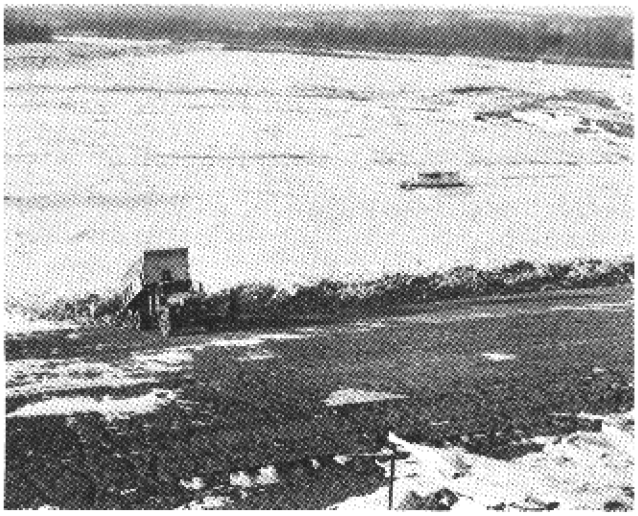
Meanwhile, District personnel were involved in flood fighting during major floods on the Des Moines River in 1944, 1945, and 1946. The Flood Control Act of 1944 expanded District flood activities in several directions.[12] It authorized the creation of Red Rock Reservoir on the Des Moines River south of Des Moines, with a total capacity of 1,200,080 acre-feet, which replaced a reservoir projected earlier at Howell. The 1944 act also authorized the first major urban flood control project in the Rock Island District; improvement of the Des Moines River through the city of Des Moines. The Act appropriated $10,000,000 for flood control in the Upper Mississippi basin, including the Red Rock Project.

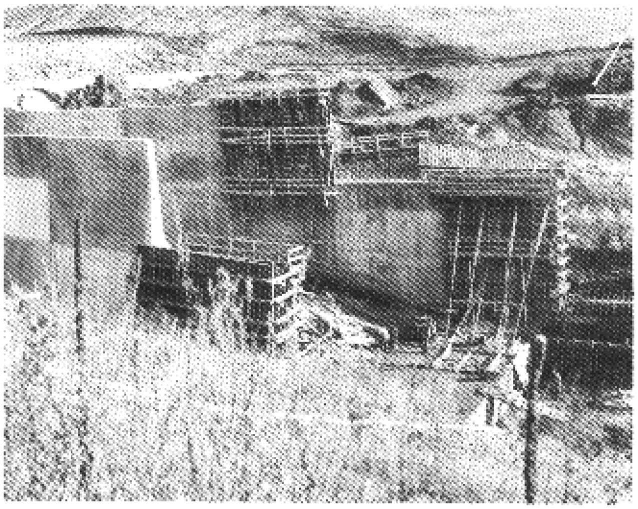
The Flood Control Act of 1944 for the first time authorized the Corps of Engineers to provide for recreational facilities at its projected sites and to contract for the sale of surplus water for domestic and industrial purposes. This latter provision primarily affected Corps projects planned for the arid and semi-arid Western states, but the provision for recreation was to have an important impact on the responsibilities of the present Rock Island District at the reservoirs and elsewhere.

The 1944 act made one important change in procedure: it required the Corps to submit proposed project plans to each affected state for official review.

The original plans for Red Rock Reservoir called for an earth-fill dam with a crest elevation of 814 feet above sea level and a length of 1,000 feet. In accordance with provisions of the 308 Reports of





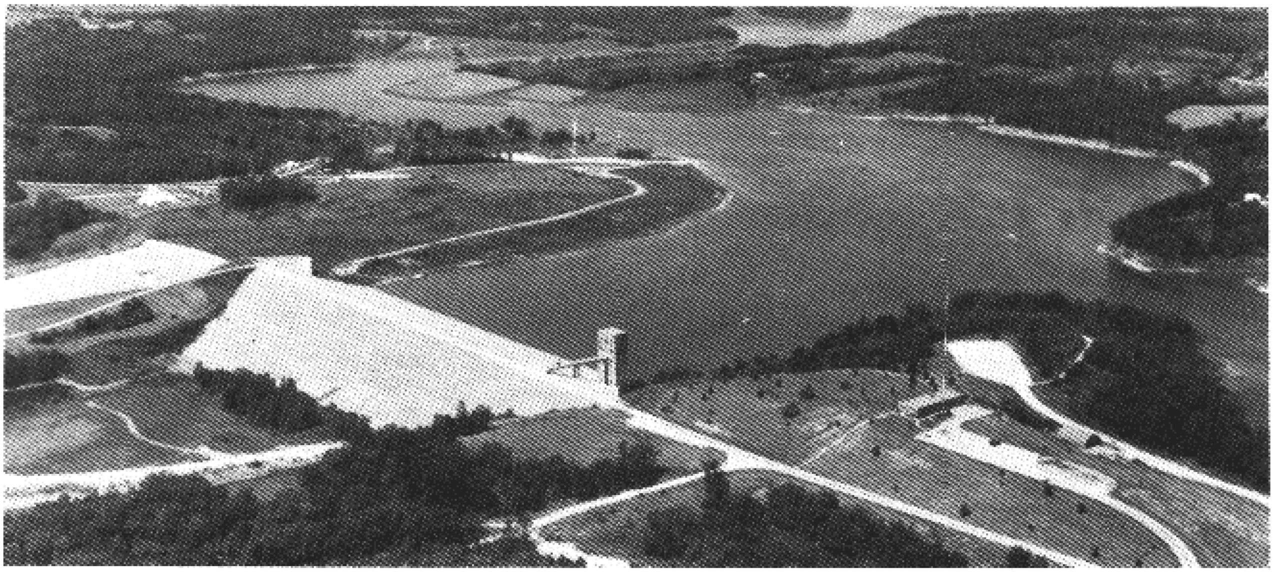


The beginning of dam construction at Coralville Reservoir.

Riprap operation on the upstream slope of the Red Rock Reservoir dam.

Construction of the outlet works at Saylorville Reservoir.

An overview of the completed facilities at Coralville.



1927, engineers planned a powerhouse with a capacity of 8,600 kilowatts as part of the project. Of the planned volume of 1,200,000 acre-feet, 800,000 was designated for flood control and 400,000 for power and recreation. The estimated cost of the project in 1944 was $20,710,000. By 1948 this Bad already risen to $53,000,000.

En 1946 Congress, continuing it3 growing interest inink-agency cooperation, gave the Fish and Wildlife Service broad powers of consultation where alteration of natural stream conditions were contemplated.[13] District personnel have worked especially close with this group during planning and construction of the reservoirs.

Construction of Stage 1 of the Coralville project finally began in 1949 with site clearing, construction of field office buildings, and erection of the earth embankment portion of the dam. Stage 1 was finished by 1950 and work began on the outlet works, At this point both Coralville and Red Rock felt the effects of yet another war: the Korean conflict. During 1953-54, civil works in the Rock Island District fell to a low ebb. Construction on Red Rock had not yet begun and no funds had been appropriated for it, and in 1954 it was placed under "inactive flood control projects."

Work on Coralville Reservoir resumed again in 1965 with Stage 3, spillway and completion of the embankment. The Iowa River was diverted through the outlet works in June 1956, and in February of 1958, Coralville began operations for flood control, providing protection for 1,703 square miles of knd along the Iowa River below the darn. As with the other reservoirs, Coralville also provides low water protection. The normal flow of the Iowa River is 1,607 cubic feet per second, but it has reached a3 much as 42,500 cubic feet per second at Iowa City during the record flood of 1918, and as low as 29.6 cubic feet per second, reached in October of 1916. Water is stored in the reservoir during high water and released during low water to even the flow of the river as much as possible.

As finally completed, Coralville Reservoir created a 4,900-acre lake that extended for 21.7 miles up the Iowa River above the dam. This permanent lake contains about 53,750 acre-feet at the normal pool elevation of 680 feet above sea level. Coralville Lake is kept at this level, excepting abnormal conditions, from June 15 to September 25, the recreation season. The level of the lake is raised 3 feet from September 25 to December 15 to send additional water into a 13,000 acre "Hawkeye Wildlife Area" managed by the State of Iowa at the upper part of the project. On February 1 each year the pool is lowered to 670 feet above sea level for four months to handle anticipated spring floods.

Water can be stored in Coralville Lake up to the spillway height of 712 feet above sea level. At full flood pool elevation the lake extends upriver for 41.5 miles and covers an area of 24,800 acres (compared to 4,900 acres for the permanent lake), containing 475,000 acre-feet of water.

The dam at Coralville is composed of two sections, an earth embankment 1,400 feet long and 22 feet wide at the top, built to an elevation of 743 feet above sea level; and a 500-foot-long concrete overflow section, the spillway, 712 feet above sea level. Under normal conditions, the water does not go over the spillway; rather, it is released through a 350-foot concrete conduit, 23 feet, in diameter. Water flow is controlled by three control gates, each 8.33 by 20 feet.

In the same year that Coralville Reservoir was put into operation, the Flood Control Act of 1958 authorized planning for a supplemental flmd control reservoir on the Des Moines River upstream from Red Rock Reservoir, about 11 miles above the city of Des Moines. This was Saylorville Reservoir, for which preliminary planning began in October of 1959.

The first construction money for Red Rock was appropriated in 1959, by which time estimates for the project had reached $75,200,000. Model tests of the spillway were made at the U.S. Army Waterways Experiment Station in Vicksburg, and construction began in the summer of 1960.

Work on Red Rock continued steadily from 1960 until it was completed in 1969. Contractors built an impervious earth-fill embankment 110 feet high and from 680 feet wide at the base to a crown width of 44 feet. At the same time, extensive work went on to acquire the necessary land for the lake and to relocate people and structures. A total of 47,000 acre3 was purchased for the project, Within this area, portions of two towns and m e unincorporated community had to be relocated above the flood control pool. In addition, the project necessitated the relocation of 42 miles of state and county highways, 96 miles of railroad track, 255 miles of electric power and telephone lines, two miles of natural gas lines, and sight cemeteries.

In naming this project "Red Rock" the Corps continued a policy of naming: lakes after local communities. In this case, Red Rock was a historic and notorious village founded in 1843 beneath the rad sandstone cliffs along the Des Moines River just across the boundary line between Sac and Fox Indian Territory and hard newly obtained by the United States. Frequent floods and even more frequent violence had given the small village a reputation that lasted until the site disappeared under the waters of the new lake.

Red Rock Reservoir was completed on schedule in the summer of 1969 and dedicated on September 5-7. Unexpectedly, those attending the dedication saw Lake Red Rock at full elevation. An extremely heavy flow in mid-August had filled the reservoir to its permanent level of 725 feet above sea bvel in three days.[14] This was more than 40 feet over the planned bval and resulted in an estimated savings of $6,000,000 in damages during its; first 135 days of operation.

The permanent lake of 10,400 acres created by the dam is one of the largest lakes in Iowa. Lake Red Rock extends upstream from the dam for 11.3miles at a normal elevation of 728 feet above sea level. At full flood pool elevation of 780 feet above sea level, Lake Red Rock increases to 65,500 acres and extends upstream for 83.5 miles to the south limits of the city of Des Moines.

The dam at Red Rock is similar to that at Coralville, with an earth embankment 5,676 feet long and 110 feet high with a 658-foot width at the base. The concrete spillway section controls the flow of water with five Tainter crest gates each 41 by 45 feet. The normal water outlet is through 14 concrete conduits, 5 by 9 feet each. The final cost of Red Rock Reservoir to its completion in 1969 was about $85,000,000.

Red Rock serves three purposes, as do the other reservoirs in the system. Its major use is to control floods on the Des Moines River below the dam, and on the Mississippi River below Keokuk, where the Des Moines enters. Flooding on the Des Moines River was even more serious than on the Iowa River. Severe f l d s had caused extensive damage in this region in 1851 and again in 1858. Flooding in 1903 caused 8,000 people to evacuate their homes in Ottumwa, Iowa. Three severe floods in 1944, 1947, and 1954 had caused $51,000,000 in damages to towns such as Ottumwa, Eddyville, and Eldon, and to thousands of acres of farmland. The June 1947 flood, one of the worst in Iowa history, flooded large sections of Ottumwa and caused more than $30,000,000 worth of damage. Since its completion in 1989, Red Rock has prevented flood damage in excess of $29,000,000, primarily from severe floods in 1969 and in 1973.

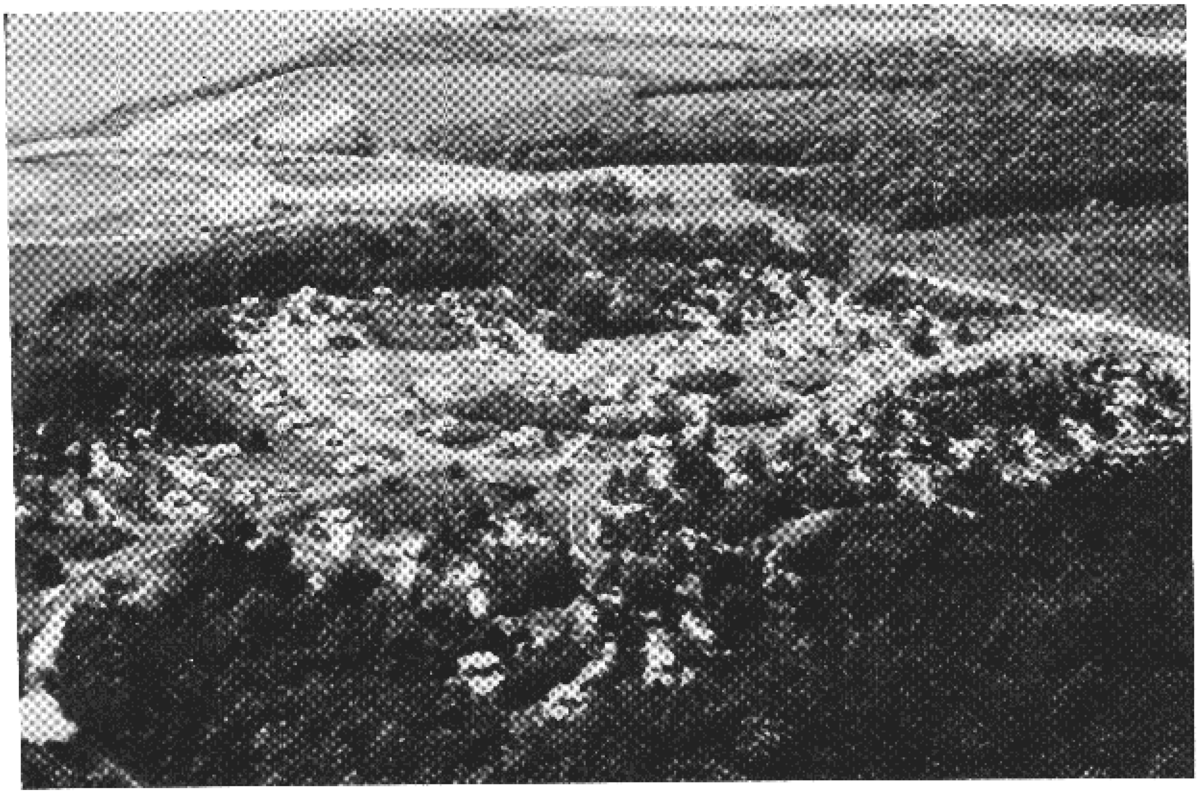
The second purpose of Lake Red Rock, as with Coralville Lake, is tu supplement low water on the Des Moines River with enough water to maintain a flow of 300 cubic feet per second at Ottumwa in order to provide good water for the many communities downstream who use the river for drinking and sanitation purposes. During the severe low water of 1977, the outflow did drop to 200 cubic feet per second to conserve all the water possible, but even this was far better than the 30 cubic feet per second Ottumwa experienced during the low water of 1940.

In addition to flood and low water control, Lake Red Rock serves a large metropolitan area in central Iowa as a needed recreation site. More than 1,000,000 visitors annually use one or more of the recreational facilities operated or supervised by the Corps. Wildlife also benefits from the project. Together with the Iowa Conservation Commission and the Bureau of Sport Fisheries and Wildlife, the Corps developed thousands of acres of the project lands for intensive wildlife and waterfowl management.

The first plans for Saylorville Reservoir were drawn up in 1960 and called for a project estimated at $49,500,000. Saylorville was designed to supplement the water-storage and water-releasing capacity of Red Rock Reservoir and specifically to protect Des Moines from high water. Plans called for a rolled earth embankment 6,050 feet long extending from bluff to bluff across the valley floor of the Des Moines River at a maximum height of 125 feet.

Construction of the earth dam at Saylorville began in 1965. The spillway and outlet works were completed in 1970. The project was originally scheduled fur completion in 1975, but in 1972, before the final stage, completion of the earth embankment, was finished, conservation and environmental groups caught up with the project and had it halted by the courts pending completion of an environmental impact study. Such studies are now a standard part of all preliminary surveys and examinations by the Corps, but Saylorville was planned before such studies were common. Environmental groups were especially concerned with the impact of impounded flood waters on Ledges State Park at the north and of the future lake.

As per court order, District personnel completed a final environmental impact statement and work at Saylorville resumed. The dam was completed in 1975, but was not put into operation, pending further studies and recommendations from both envi-



In addition to their primary purpose of flood control, the reservoirs serve a wide variety of recreational and conservation interests.

ronmental groups and the Corps. Finally, in 1976, Congress authorized a project modification to minimize the adverse effects at Ledges State Park. These modifications included the acquisition of an additional 2,200 acres of land between the dam and the city of Des Moines for use as a green belt to allow the earlier release of flood water and a consequent lessening of the flooding at Ledges.

After 12 years of construction, the flood gates at Saylorville were lowered into position on April 12, 1977. The occasion was marked by a ceremony that morning led by Rock Island District Engineer Colonel Daniel L. Lycan and Iowa Congressman Neal Smith. Extremely low water during the 1977 spring and summer slowed the filling process. Not until September 9, 1977, was the normal lake level of 833 feet above sea level reached.

As finally completed, the dam at Saylorville Lake is an earth embankment 6,750 feet long at its crest and 105 feet high. A 430-foot-long concrete spillway is located at the west bluff, with a crest 31 feet below the earth section of the dam, or 884 feet above sea level. The structure is a chute spillway with an uncontrolled concrete weir. Flood water flowing over the spillway ends in a concrete stilling basin and then flows though an excavated pilot channel to the river. Under normal conditions water is released through a 22-foot-diameter concrete conduit through the base of the dam, with the flow controlled by three electrically operated gates in a control tower. At the normal lake level of 833 feet above sea level, Saylorville Lake extends upstream for 17 miles and covers 5,400 acres. Under maximum flood storage conditions, the impounded water extends upstream for 54 miles over 16,700 acres, with a volume of 602,000 acre-feet. The reservoir holds the flood waters of a 5,823-square mile watershed.

Several other sites for reservoirs have been examined over the past years, but the only remaining reservoir to reach the planning stage was on the Skunk River north of Ames, Iowa. This project was placed in an inactive category in June 1974 because of state and bcal opposition,

At Saylorville, as at the other two reservoirs, recreation has become the guise by which most people have come to know the site. By 1980 more than 2,000,000 people annually were using the Corps' supervised facilities at Saylorville Lake. At the five major recreation areas established by the Corps, modern campsites with full facilities, including several winterized sites, boat ramps, sandy beaches, and a well-stocked lake attract vacationers, nature lovers, and sportsmen. Together with Coralville and Red Rock, more than 5,500,000 people used the recreation facilities at the reservoirs in 1980.

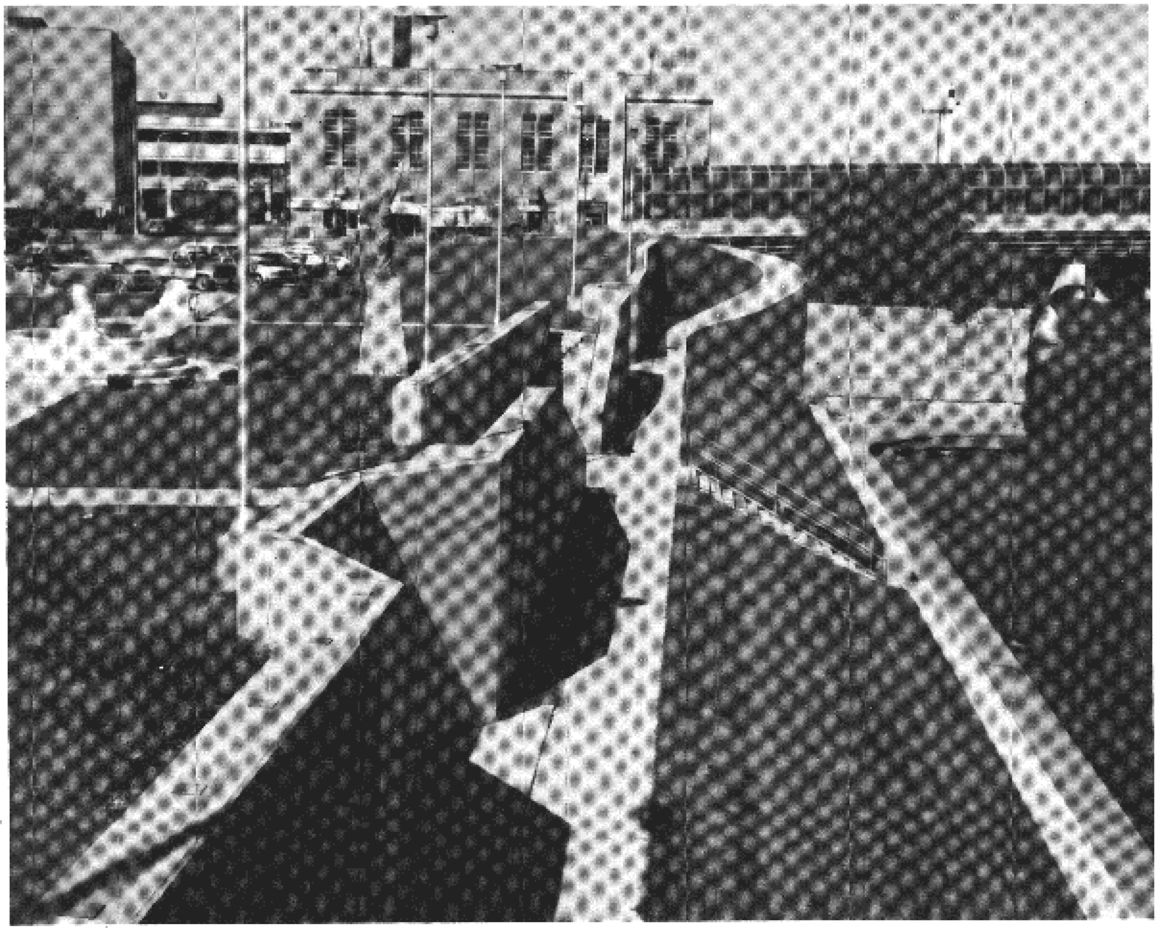
Other Flood Control Measures. Following heavy floods in the spring of 1943 and again in 1944, Congress authorized a total of $22,000,000 to be appropriated aa emergency funds disbursed by the Secretary of the Army and the Chief of Engineers for repair, restoration, and strengthening of levees and other flood control works threatened or weakened by floods. This fund was supplemented by an additional $12,000,000 in 1945 and $15,000,000in 1947. Of this sum, the Rock Island District received just over $350,000 for lave repair in 1944 and $749,461 for 47 levee repair projects in 1947. Funds from this appropriation do not need prior approval for each individual project, and are in addition to regularly authorized projects, Under this appropriation, the District continues to undertake several emergency projects each year. These may involve work during a flood or repair to flood control or navigation structures damaged by a flood.

Projects funded from regular appropriations have primarily been the construction or the bringing up to grade of rural and urban levee systems. By far the largest of the rural levee projects was the Sny Basin, authorized by the Act of July 24, 1946. Its estimated cost in 1946 was $6,477,000, but its final cost when it became operational in 1967 had risen to $13,822,605.[15]

The Sny was a former by-channel of the Mississippi in Pika, Adams, and Calhoun Counties, Illinois. The project was for reduction of interior flooding through a comprehensive system of retarding reservoirs, diversion channels, pumping stations, closing levees, and drainage culverts and aqueducts.

Work on the project wa3 slow in starting and was slowed even further by the Korean conflict, but in 1954 Congress authorized construction or modification of 14 rural levee protection projects within District boundaries. These projects downstream from Rock Island involved 335 miles of levee construction to protect 325,060 acres of agricultural land along both sides of 200-mile stretch of the Mississippi River. All of these projects have now been completed, while others of a similar nature have been authorized on both the Mississippi and on many of the tributaries.

Presently, the Rock Island District is completing a study of all existing Corps projects in the levee



places along the waterfront, industries depended on the river for their operation or had constructed buildings too close to the water's edge for a levee.

Construction of the Dubuque Local Flood Protection project began in 1968 after careful planning and testing by both Corps and contractors. In addition to sections of earth levee, the Dubuque project involved concrete and steel walls, closure structures, a navigation opening for the commercial harbar, and interim drainage facilities. The levee part; of the project was completed in early spring of 1973 in time to show dramatic results in protecting Dubuque from the devastating 1973 flood.

Following completion of the levee system, work continued on the recreation facilities of the project, including public access to the riverside of the levee. Sidewalks and steps were located on the riverside to provide public access to the river for various kinds of recreation. Also as past of the project, a native stone lookout tower, the Dove Overlook, was rebuilt, with access from the top of the levee. Along with the recreational facilities developed by the Corps, the city of Dubuque built two bicycle trails along the top of the levee. These recreational additions completed the Dubuque project and were dedicated on July 29, 1978.

Two other urban flood control projects were dedicated during the summer of 1978. The Rock Island Local Flood Protection project was a direct response to the 1965 flood, the worst in Rock Island's history. Although the project had received Congressional authorization in 1962, only small mounts of money had been allocated for preliminary studies prim to 1968. Even though the project faced the usual problems of land acquisition, of city cooperation in the removal of sewer, water, and electrical lines, and of aesthetic objections raised by some residents wherever any levee system was proposed, cooperation between city officials and District rep resentatives: was good and few major problems arose to slow the work. Construction on the Rock Island lave began in 1971 and was complete enough by 1973 to aid the city during the 1973 flood. The project was dedicated on June 24, 1978. To that point the project consisted of three and onehalf d e s of levee along the river built to 572 feet above sea level, or 7 feet above the crest of the 1965 flood. The cost was $9,600,000, of which $1,280,000 came from the city of Rock Isknd and the remainder from Federal funds. Since 1978 work has continued on recreational facilities in connection with the levee, including scenic overlooks, fishing access areas, a baseball field, shelter, and a nature trail. The third urban flood control project completed in 1978 was the project to protect Marshalltown, Iowa, from the Iowa River. The Marshalltown project was dedicated on July 16, 1978.

Three additional urban flood control projects are nearing completion: at Waterloo, Clinton, and Marengo, Iowa. The largest of these, the Waterloo bcal flood protection project, consists of a 17-mile system of levees and floodwalls. This project, begun in 1972 following Congressional authorization in

1965, will protect Waterloo from major flooding on the Cedar River and Black Hawk Creek at an estimated total cost of $48,830,000. Along with the levees and floodwalls, the Waterloo project includes eight pumping stations, ponding areas, closure structures for streets and railroads, changes in interior drainage facilities, a ring levee surrounding the Waterloo sewage treatment plant, and a small reservoir to hold the excess flood water from Virden Creek. The project at Waterloo is an especially good example of how an urban flood protection system can be handled with attention to aesthetics and recreation. The levee system runs through a section of downtown Waterloo scheduled for renewal and beautification by the city, and every attempt was made in the design of the levee to fit in with this plan. For example, the project includes sections of lowered floodwalls to give residents a better view of the river and of Waterloo's Recreation and Arts Center Building. During floods, closure panels will be used at these lowered sections, Another two-block earth section of the levee has been contoured into free-form hills. These "Mounds" as they are called, provide flood protection, but they also are pleasing to the eye. Another portion of earth levee has been shaped into an amphitheater facing the Cedar River for future use by the city of Waterloo.

At still other places along the project, concrete levees have been placed back to provide room for sidewalks, stairways, and park benches dong the river's edge. The pleasing and imaginative Waterloo project was awarded an honorable mention in the engineering category in the 14th annual U.S. Amy Chief of Engineers Design and Environmental Awards Program in 1979.

At Clinton., Iowa, the flood control project was authorized by Congress in 1968 and begun in 1974. It consists of two systems, one along the Mississippi River and Mill Creek and the other along Beaver Slough. The Mississippi section has been completed, and consists of 8.1 miles of earth levee and 3,080 feet of I-type concrete floodwall, as well as an interceptor sewer, pumping stations, closure structures, ramps, ponding areas, and gate wells. Work on the Beaver Slough segment of the project was completed in 1981.

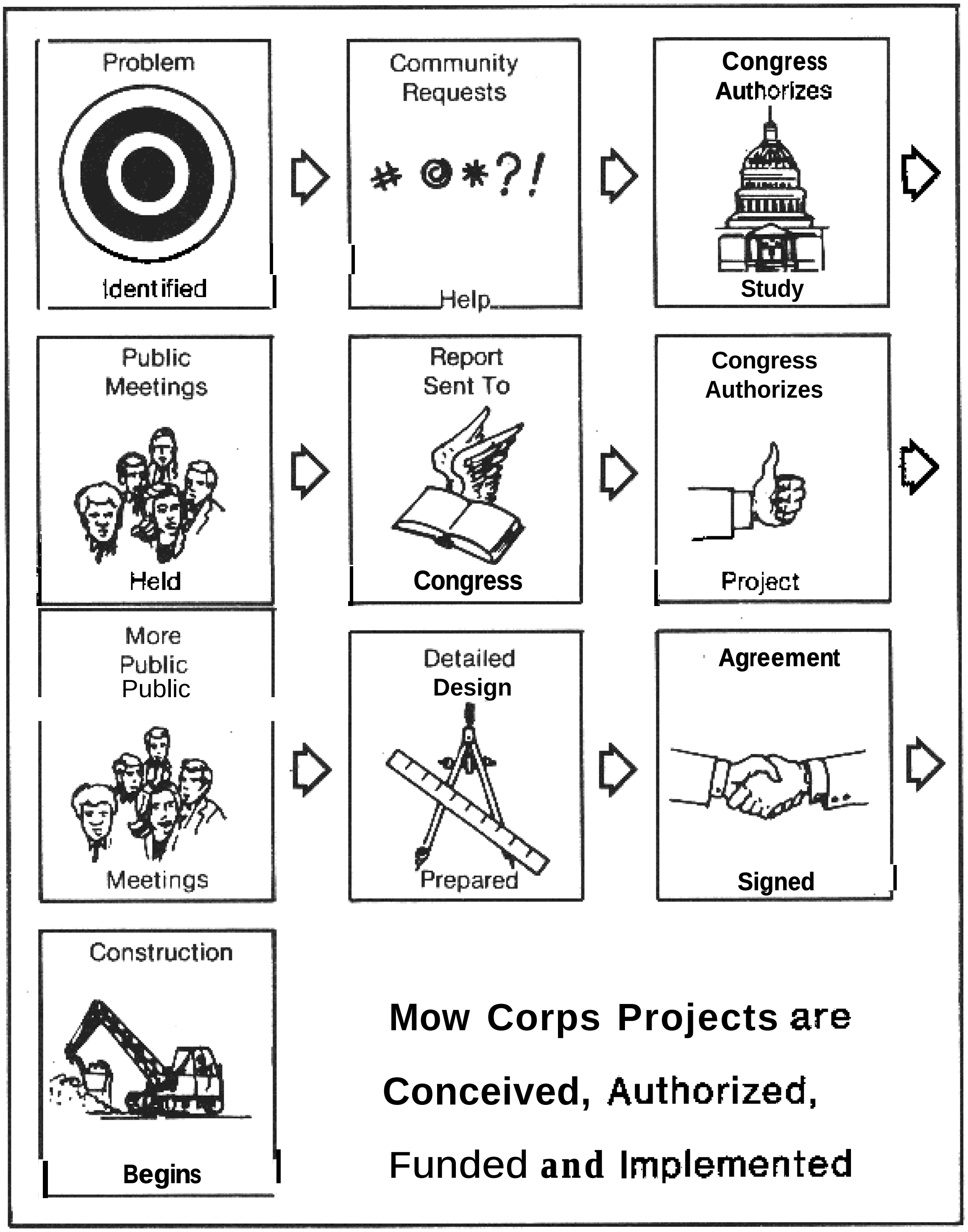
Several other lesser flood control projects remain in various stages of completion: the Fulton Local Flood Protection project begun in 1977; the Kent Creak Local Flood Protection project at Rockford, Illinois, begun in 1978; and the East Moline, Illinois, Local Flood Protection project begun in 1979.

In addition to local flood protection projects, the Corps of Engineers alar, performs several other flood-related services. Engineers are available on request from communities to serve as advisors during flood fighting activities. The Corps also maintains an information service to keep local news media up-to-date on flood information before, during, and after a flood.

The Flood Control Act of 1960 authorized the Corps of Engineers to develop and provide information about flood hazards to states and communities. The purpose of these flood plain information studies is to aid local governments in regulating flood plains so as to avoid or minimize future damage. A state or other responsible governmental agency must request them studies and agree to disseminate the final report, and the application for a study must be approved by the Chief of Engineers before the surveys and examinations are begun. More than 20 of these studies have been completed in the Rock Island District.

Procedures for Flood Control Projects.[16] The procedure by which a community obtains a flood control project is a complicated and long one, as can be seen from the many years which usually pass between authorization of a project and it3 completion. Critics of the Corps of Engineers are fond of suggesting that the Corps, looking for work to do, intrudes its will on community affairs in order to build unwanted levees. In fact, just the reverse is true.

The process which ends with a levee on the waterfront begins with a request from the people with a


Problem
Identified
Community Requests
@ * ? !
Help
Congress Authorizes
Study
Public Meetings
Held
Report Sent To
Congress
Congress Authorizes
Project
More Public Public
Meetings
Detailed Design
Prepared
Agreement
Signed
Construction
Begins
Mow Corps Projects are
Conceived, Authorized,
Funded and Implemented

A chart showing steps necessary for a city or rural drainage district to obtain a flood control project.

problem—local residents whose houses, businesses, or farms are being flooded. Community officials request help with their flood problems through their senators and representatives. One of these congressmen, in turn, introduces a resolution into the Public Works Committee of the House or Senate calling for the Corps of Engineers to study the feasibility of providing flood protection.

These preliminary reports may be favorable or unfavorable to Federal involvement in the local project, but even if the studies are favorable, the movement toward a levee or floodwall is a complicated process taking an average of nearly 10 years—much longer if there are problems with funding or difficulty in obtaining community consensus. The process involves community meetings, many studies and reports in increasing detail, investigations of alternate possiblities and of such factors as impact an the environment, social impacts, and the effect of the project on the regional economy. The Carps of Engineers may favor one form of improvement over the other, but generally the local residents are presented with several alternative plans which vary not only in design but in expanse and aesthetics. In most cases, an earth levee is the least expensive but the most obtrusive and obstructing. Once the possible options have been presented to groups of local citizens, who must share part of the cost, it is up to the local government to choose one of the alternatives or none. A visible indication of the different directions such negotiations can take can be seen in Davenport, Iowa, and Rock Island, Illinois, across the river from each other. Both cities were hard hit by the 1965 flood, and pushed for flood protection projects. Both went through much the same series of meetings, proposals and alternatives, but Rock Isknd officials were able to agree on what was needed, while Davenport, just as aware of the need for flood protection, remains deeply split on a number of critical issues. The process by which a community obtains a flood control project is illustrated on page 312.

Floods

Record-breaking floods occurred on the Mississippi River in 1951, 1966, and 1973. A comparison of these three floods illustrates how varied Mississippi floods can Be. The wide drainage basin of the Upper Mississippi provides a range of factors which can form different combinations to cause different kinds of floods.[17]

The Flood of 1951. In an area as large as that of the Upper Mississippi basin, several conditions must coincide for major flooding to occur. Such a set of conditions occurred in April and May of 1951, resulting in a flood that exceeded the previous record flood of 1880 at nearly every location from Dubuque to the lower limit of the Rock Island District.

Warm weather toward the end of March combined with six major and several minor rainstorms throughout, the District between April 1 and May 18 produced a prolonged period of flood stage on most, of the upper Iowa and Illinois tributaries.

However, these conditions merely set the stage for the major contributing cause of the 1951 flood, a heavy snow melt during April from the central portions of Minnesota and Iowa. March was a wet month over the entire Minnesota River watershed, with an average 36 inches of snowfall, compared to a normal average of *8* inches.

Although the spring break-up during the second week in April did not extend up the Mississippi beyond the mouth of the Minnesota River, the malt in central Minnesota was rapid. The resulting flood an the Minnesota River was the most disastrous flood in Minnesota's history. Especially hard hit was Mankato, where the crest flow was about 50% greater than the previous record flow. In Wisconsin, the St. Croix, Chippewa, Black, and Wisconsin Rivers contributed to the flood.

By April 15, severe flooding was forecast in the Mississippi Valley. Water coming down the Mississippi, combined with the April ice breakup and the water from storms and swollen tributaries produced a record flood.

The crest of this flood reached the upper end of the Rock Island District on April 21 and reached Dubuque the next day. At Dubuque the river stayed close to the crest level for five days. Aa the flood moved downstream, the crest lengthened, remaining at Rock Island for nine days, at Burlington for 14 days, and at Quincy for 16 days.

The seriousness of the flood became apparent about a week before it arrived. The Corps used this lead time to participate in several flood prevention measures. Mayors, representatives of business and industry, and others interested were invited to meetings at Dubuque, Clinton, and Rock Island, where representatives of the Corps discussed the impending flood,

Technical personnel from the Rock Island District were stationed in problem areas throughout the District during the critical flood period to give advisory assistance on *emergency* flood protection. In addition to the regular work force at the District Office who performed flood fighting as part of their normal work, 65 more personnel dropped their regular duties to participate in the District's flood activities.

The Corps assisted in many other ways a3 well: collecting rainfall, weather, and river stage information for local authorities; informing the Coast Guard, Red Cross, and other agencies of flood conditions, patrolling levees and other trouble spots. In addition, the District procured flood fighting equipment from its stock of materials. These included 375,000 sandbags. The total spent by the Corps on these emergency activities was $110,000.

Following the flood, the District made field observations of damages. Property and wage bas was particularly severe in the urban areas. Although the flood inundated many acres of farmland in the southern part of the District, it came at a time when there was little loss to crops and only a slight delay of the planting season.

Front Street in Davenport, Iowa, during the 1888 flood.

Several communities along the main stem of the Mississippi were hard hit, but nearly everywhere, existing flood protection works and additional emergency construction prevented even more serious damage. Towns like Dubuque where the flood stage exceeded the 1880 record by one foot could have been hard hit, except for the rapid construction of temporary dikes. Industries installed pumps and moved equipment to upper levels, so that while Dubuque experienced flooding of some low-lying residential areas, and had problems with its sewer system, damage was less extensive than it might have been,

The story was the same downriver. Only in locations where bvee systems failed was there much damage, Two island communities at Campbell's and Smith's Islands had to be evacuated.

The Rock Island District's after-flood report put the total damages in the District, both rural and urban, at $9,403,900 dong the Mississippi River, with another $775,035 of damages dong the tributaries. While 4,917 persons were displaced for shorter or longer periods of time, advance warning helped keep the loss of life to one, a drowning at De3 Moines attributed to the flood.

An estimated $18,960,730 of damages was prevented by the advance warning and another $15,851,400in damages was prevented by flood control projects—mostly rural levee systems—within the District.

The 1965 Flood. Less than 15 years after the record flood of 1951 the Mississippi Valley experienced an even more memorable flood. The flood of 1965 was one of the most were floods on record from the headwaters area of Minnesota to the confluence of the Illinois and Missouri Rivers near St. Louis. It was the kind of flood those who lived though will tell their children about.

A3 with the 1951 flood, several necessary factors combined to cause this flood. Upstream areas of the Mississippi basin received above average rainfall in August and September of 1964. The ground was wet when the winter freeze-up occurred. En December the weather grew cold, causing deep frost penetration and rendering the ground impervious to the spring's melting snow and to rainfall. Rain in February and above-freezing temperatures during the month increased the water content of the snow cover. Finally, above normal snowfall occurred during March over the whole basin. The Weather Bureau at St. Paul recorded a total snowfall of 73 inches, compared to an average of 45-50 inches.

By the end of March it was apparent that a flood was coming. On March 31 the Rock Isknd District prepared a flood potential report. The impending flood was given wide coverage by the news media and once again, the Mississippi Valley began preparatory measures. During the first week of April the Corps established communications with threatened communities. A 24-hour surveillance was established and around-the-clock construction was begun at critical sites. As with the 1951 flood, District technical personnel were sent to critical areas.

Clinton, Iowa, during the 1951 flood. A Mississippi flood often hides the damage it does under a calm surface.

A chronology of flood-fighting efforts at Rock Island was repeated at towns up and down the river. On April 9 the U.S. Weather Bureau predicted a flood crest at Rock Island of 19.5 feet, 4+5feet over flood stage. The following day Rock Island began strengthening and elevating its existing dike system. On April 12 the Mississippi rose an ominous 1.1 feet in 24 hours, and sandbag loading facilities were put into operation at the Mill Street incinerator. Representatives of the Corps, the city, and local business and industry met to discuss strategy should the dikes not hold.

On April 15 the Mississippi rose above the 15-foot flood stage at Rock Island, while heavy rains slowed work on the dikes and weakened them. By April 16 the Weather Bureau had revised its, flood crest upward to 20.5 feet, causing concern that water would flood the city dump and drive rats to higher ground. Anticipating this, Rock Island increased rat poisoning efforts and set up typhoid innoculation centers.

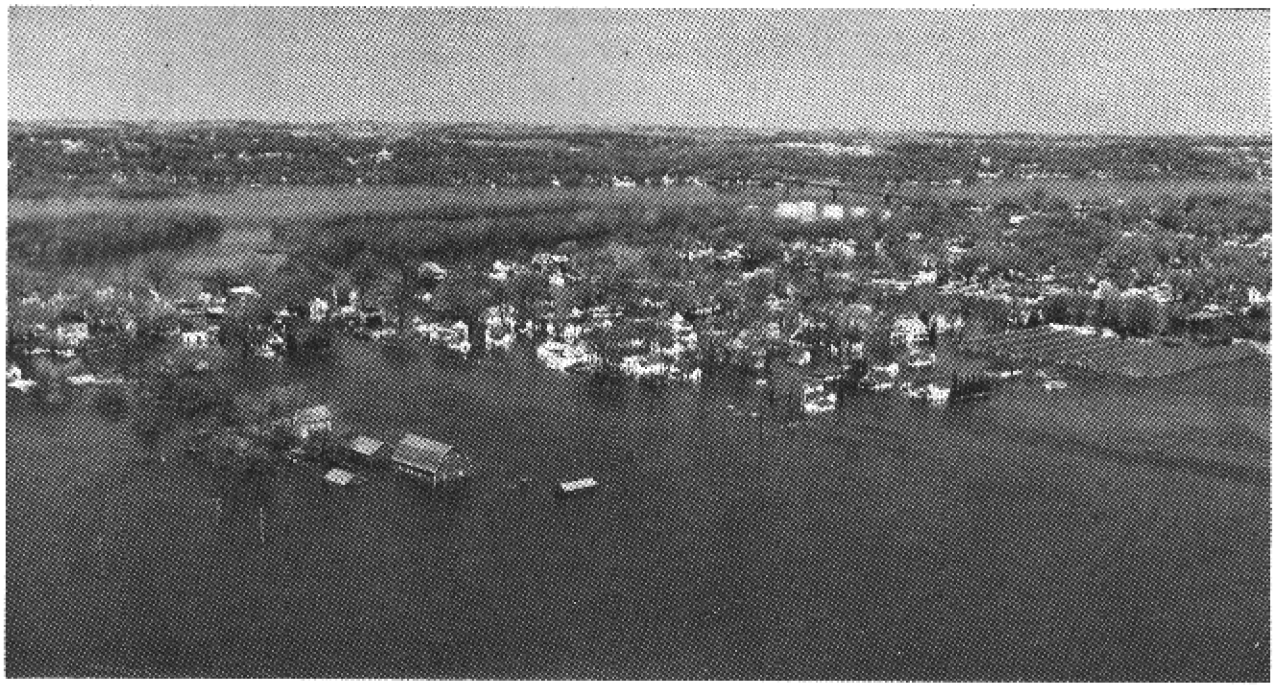
With the river stage at 15.9 feet on April 17, Rock Island officials requested more volunteers to shore up weak dikes and fill sandbags. As the river continued to rise, to 16.4 feet on April 18, to 16.7 feet on

April 20, to 17.2 feet on April 21, the Red Cross set up additional shelters, the Salvation Army began serving food to flood fighters, and the telephone company installed emergency phone service at potential flood spots. The Corps acquired 10,000 additional sandbags and established second lines of defense behind potential weak spots in the dikes. Meanwhile, crest estimates continued to be revised upward nearly every day, to 21 feet on April 20, to 21.5 feet on April 22.

On April 21 downtown Rock Island businesses began evacuating basements and sandbagging around their buildings. On April 22 the Rock Island Police went on 12-hour shifts, with all leaves cancelled, as 24-hour foot patrols on the dikes began. Illinois Governor Otto Kerner and Congressman Gale Schisler visited the flood protection works.

On April 23, with high winds and additional rain beating at the dikes, and the flood stage at 19 feet, the Red Cross set up an evacuation center at the Prince Hall Masonic Home. The following day Rock Ishnd established evacuation headquarters at Rock Island City Hall as more than 2-1/2 inches of additional rainfall caused a revision of the flood crest to 22.5 feet. Several families were evacuated from low-lying areas and downtown businessmen were warned that, the rain-weakened dikes would probably break in less than 10 hours. Additional second lines of defense behind weak dikes were built by flood fighters who worked past midnight to get the job done.

On April 25, with the river stage at 21.42 feet, a break in the dike near the Rock Island Boat Club flooded the sewage disposal plant, the Container Corporation plant, and Macombers. An appeal went out for more volunteers as the crest continued to rise. The next two days were the most critical. On April 26 the dike broke by the J. I. Case Plant and a new dike had to be built at Third Avenue, Schools were dismissed to provide additional volunteers to fill sandbags. For several day3 hundreds of high school and college students had already skipped classes to volunteer as flood fighters. Many




LINES
BOWLES
CLOTHIERS
SHOES
BAUMGARTNER'S
CAUTION

Fulton, Illinois, during the 1965 flood, one of the worst floods in the District.

Main Street in Hannibal, Missouri, during the height of the 1965 flood.

teachers worked alongside the students or provided transportation from the schools to the flood site. Volunteers worked around the clock to build a new dike under Centennial Bridge to save the downtown from flooding. By April 26, flood water had reached Third Avenue at some points.

On April 27 the river stage went over 22 feet and water began backing up through storm sewers. Sand boils developed behind the dikes, and 100,000 sandbags and thousands of cubic yards of clay were used to build a new dike. In addition to the Red Cross and the Salvation Army, many other organizations donated money, food, clothing, and time to aid flood fighting efforts. The Red Cross was taking care of 464 evacuees in temporary shelters.

At 11:30 on the morning of April 28 the Mississippi finally crested at 22.5 feet, but all dikes held. An emergency dike had to be built around the water treatment plant because of water seepage; however, the worst was over. April 29, with the river stage at 22.48 feet, the water began to drop — slowly. Still, volunteers and patrols continued their work.

The Mississippi at Rock Island reached a level 3.1 feet above the previous record. Indeed, over almost the entire length of the Mississippi, the flood crest attained record levels. The crest exceeded the previous maximum at Guttenberg, Iowa, by about 4 feet. Because of the record amount of flood water, the flood stages lasted longer than the 1951 flood, lengthening as the flood came downstream. At Dubuque the river rose above flood stage on April 1 and remained above for 26 days. At Hannibal, Missouri, the flood stage lasted 43 days.

As with the 1951 flood, much damage was prevented by advance warning and preparations. However, with the water at stages significantly higher than those in 1951, problems were more serious and greater damage resulted. At Cassville, Wisconsin, where five homes had been touched by the 1951 flood, 69 residences were affected in 1965, forcing evacuation of 220 persons. At Dubuque, even though a 3½-mile dike was constructed after the flood warning, extensive property damage occurred. The cost estimate for industrial and residential property in Dubuque was $2,060,000 in physical damages alone, with the total cost of the flood in lost wages, property damage, and flood fighting put at $7,654,000.

The story was repeated downriver: damages to streets, storm sewers, problems with sewage disposal, interruption of railroad service, dislocation of families. Towns like Fulton and East Moline, Illinois, experienced severe damage. At East Moline

Lock 21 at Quincy, Illinois, during the 1973 flood.

One of the worst ice jams on the Mississippi occurred in February 1966. The dark strips on the ice are coal dust, dropped from a plane by the Corps of Engineers in an experiment to hasten melting.

958 homes were partially destroyed and 2,637 persons had to be evacuated.

Only a few locations escaped with minor damage. Examples were Bellevue, where precautionary measures were taken, and Galena, Illinois, and Sabula, Iowa, where Corps of Engineers' local protection projects successfully withstood the record flood stage.

The 3965 flood caused more damage to rural areas than the 1951 flood had, But again, little actual damage to crops occurred because of the season. Mast rural damage was to cabins and cottages extensively built up along the shores.

Final estimates of damages due to the 1965 flood put the total cost (property, lost wages, flood fighting) at $55,566,600. Of this, $37,633,700 was damage to urban areas. Although there were no deaths attributed to the flood, 12,956 persons were displaced. Expenditures by the Corps of Engineers in the Rock Island District amounted to $1,965,000. Although many communities experienced serious economic loss, the Corps' estimate of damages prevented due to advance warning was $174,394,600.

Between the 1951 and 1965 floods a number of flood control projects had been completed by the Rock Island District and a number of others had been authorized and were partially complete. District personnel estimated that one project alone, the Coralville Reservoir, prevented $1,500,000 in damages. The estimate of the total damages prevented by completed and partially completed flood control projects was $29,812,000. Had all of the authorized projects been completed in time for the flood, an additional $51,400,000 might have been prevented, including $10,000,000 to the city of Dubuque alone. The 1965 flood thus increased the awareness of many communities of the need for flood control.

The 1973 Flood. The 1973 flood was different from the 1965 and 1951 floods in that it was caused primarily by continuous rainfall which brought both tributaries and the main river to high flood levels.

Rainfall in the first six months of 1973 was 220% of normal. Rainfall recorded during this period in Moline, Illinois, was 36.72 inches, or almost 4 inches more than the normal amount for a whole year. New monthly records were recorded in March and April.

The excess rainfall produced record stages on the Rock River in Illinois and on the Wapsipinicon, the Iowa, the Skunk, and the Des Moines Rivers in Iowa, as well as on several lesser streams.

Prim to the record rainfall of March and April, ice jams and above-normal stream flows caused moderate flood damage to several locations within the District. Throughout the Rock Island District the flmd emergency situation extended from January 1 to June 1, except for a brief period in late February,

Because the tributaries were at such high flood levels, each tributary stream added large volumes of water ta the Mississippi crest as it moved downstream, increasing the flood stages. That meant that at Davenport the 1973 flood ranked as the fifth highest on record, 3.5 feet below the 1965 crest, but from Burlington, Iowa, downstream, the 1973 surpassed all others. By the time the crest reached Quincy and Hannibal, it produced stages 4 feet higher than in 1965.

The 1973 flood stayed around for an unusually long time. The Mississippi was at flood stage at Quincy for 94 days and at Hannibal for 100 days. Because the flood was caused by several periods of rain rather than one large snow melt, it produced four major crests during this period.

Damage on the middle and lower sections of the Rock Island District was especially severe. Preliminary estimates showed about $410,000,000 in damages for the whole Mississippi, with about $60,000,000 of those damages occurring in the Rock Isknd District. For the first time in history, however, the Corps control measures prevented more damage than actually occurred. The District estimated that the flood protection projects already constructed in its area prevented an excess of $65,000,000 in damages.

In the period from April 22 to April 26, there were seven major levee failures within the District, inundating about 65,000 acres of farmland. Only one of these, in the Fabius River Drainage District in Missouri, was a Corps-built project. Along the entire Mississippi, the 1973 flood inundated 180,000 acres and displaced 10,000 persons.

Other Flooding. One other major cause of flooding has been a frequent problem in the Rock Island District: ice jams. Ice jams occur on the Upper Mississippi and its tributaries nearly every year, especially on areas of the Rock River. Although the majority of these jams happen in stretches of the river away from dense populations and relieve themselves naturally, they are capable of causing extensive damage.

During the winter of 1965-66 a serious jam occurred just downstream from Dam 15 throughout much of Pool 16. Warm weather in February and an uneven rock ledge bottom in this pool contributed to the backup of ice. Ice from the Rock River knitted into the mass already in the Mississippi and compounded the problem, raising the tailwater at Davenport and Rock Island above flood stage.

Engineers applied powdered charcoal, coal dust, and calcium chloride to the ice in an effort to weaken it, but the jam extended far 10 miles in the river, and only marginal results were produced. Finally, helped by rotten ice and rising temperatures, boats broke through the jam on March 1, 1966.

The ice jam caused flooding in several communities in the District and cost $900,000 in physical damages and flood fighting efforts. Davenport was the moat seriously affected, with damage to about 150 homes. One benefit of the 1966 ice jam was the initiation of a Corps-wide program of data collection on causes and methods of relieving ice jams.

Low Water. Since 1973 there have been no major floods in the Rock Island District. While the Mississippi and ita tributaries have reached or exceeded the flood stage at some point in the District almost every spring, the natural conditions which bring on a record flood have not occurred. Further, the urban and rural flood control systems completed since 1973 have helped minimize damage to towns and industries. In 1979, for example, the operation of the three Iowa reservoirs was responsible for lowering the spring flood crest at Quincy, Illinois, on the Mississippi River by 2.8 feet.

Rather than flooding, low water has been the problem. During the 1976 and 1977 navigation masons, a lack of water resulting from prolonged drought across much of the Upper Mississippi drainage basin hampered District operations. Law water created minor problems in 1976, but proved more severe in 1977 as the drought continued.

Fall rains in the Upper Mississippi basin were average in 1975, but winter snowfall in 1975-76 was below normal in most of the District, leaving little snow cover an the ground as spring approached. Some tributaries rose to flood stage and the Lower Des Moines River Basin experienced minor flooding as the result of rainfall during March and April; but following this spring runoff, precipitation fell again to well below normal, creating near record low river flows and levels from July until late October. On July 14, warnings were issued to commercial navigation regarding the low water. Commercial shipping was slowed, though not stopped, by the low water.

Drought conditions continued in earnest in the fall of 1976 as low rainfall established *many* new records. Precipitation for May through October 1976 was the lowest since 1894, with some localities receiving only half the normal amount. Continuation of the drought into the winter and spring of 1976-77 created additional problem. Both surface and subsurface water were below normal, and the lack of subsurface moisture permitted frost to penetrate as deep as 7 feet in some places. Many towns found their major water mains frozen. The lack of soil moisture also permitted strong winds to erode soil in an unprecedented manner, obscuring visibility on many days in central and northwest

Iowa. By the spring of 1977, 88 communities in the Rock Island District had experienced some municipal water shortage. Several community wells were completely dry. Above ground, the low temperatures and slow water flow permitted ice as thick as 24 inches to form on many streams.

In March 1877 Iowa Governor Robert Ray formed a Drought Emergency Task Force, which immediately sought advice from the Corps of Engineers. The Task Force requested Colonel Daniel Lycan, the District Engineer, to suggest actions to be taken during a drought. One immediate problem involving the District was the three Corps reservoirs in Iowa. By June the inflow to all three reservoirs; had dropped to the point where they could not sustain their normal minimum release rate.

Low water may not seem as dramatic as flooding, but the problems it causes can be serious. In fact, the reservoirs were designed not only to impound flood water, but to maintain adequate stream flows during low water. Low water conditions affect wildlife habitats and can seriously affect the quality of water used by communities along a river for drinking and sanitation.

Throughout the winter of 1976 and through all of 1977, the Rock Island District carefully monitored the water flow in and out of the reservoirs to insure that water quality would be maintained downriver while storing enough water reserves in the pools. During June and July of 1977, the Corps cut the outflow from Coralville Lake from it3 normal 200 cubic feet per second to 75 cubic feet per second. Outflows from Lake Red Rock and from Saylorville Lake (which had recently been completed and was still slowly in the process of filling) were also red u d during the 1977 season.

On the Mississippi, the lock and dam system did what it was designed to do when it was built in the 1930's: maintain a 9-foot channel. Although some barges did have difficulty maneuvering the channel in the low water, and although the water flow was so reduced as to give Rock Island, Davenport, and neighboring communities bad-tasting and bad-smelling water, the Rock Island District,was able to maintain a 9-foot depth on the Mississippi with minimal hindrance to navigation.

The locks and dams have almost no effect on either lowering or raising flood levels, The system was designed to deal with the low water which regularly plagued the Upper Mississippi before the darns were built, The effect of the lacks and dams can be seen by comparing 1977 to an earlier year with almast the same low water conditions: 1864. During the summer of 1864 almost no boats moved on the Upper Mississippi. From Winona, Minnesota, north there simply was no channel, People in the Rack Island-Davenport area were able to walk across the river between the two cities. Mow, by maintaining 3 channel during periods of low water, the locks and dams not only keep commercial traffic moving, they also maintain fish and wildlife habitats that in former years would have dried up and been destroyed. With the levees and reservoirs to minimize flooding, and the lock and dam system to maintain a channel in low water, the towns and cities along the Mississippi today are more prepared to cope with the wild gyrations of the Mississippi River than were the same villages 100 years ago.

Notes

Chapter 11

1. Quoted in Fugina, *Lore and Lure of the Upper Mississippi River*, p. 308.

2. The 1917 act gave more responsibility to the Corps on the Mississippi and Sacramento (California) Rivers, but the 1936 Flood Control Act was the first to authorize specific projects.

3. *Report of the Federal Civil Works Program as Administered by the Corps of Engineers*, U.S. Army, pp. 263-64.

4. Arthur Frank, *The Development of the Federal Program of Flood Control on the Mississippi River* (New York: Columbia University Press, 1930), p. 134.

5. *Annual Report*, 1885, III, p. 1710.

6. *Annual Report*, 1913, p. 1881.

7. Richard Monroe, *Notes of Interest, Rock Island District, Wisconsin River to Clarksville* (Rock Island, IL: U.S. Engineer Office, 1935), p. 14.

8. 45 stat. 469. See J. P. Kemper, *Floods in the Valley of the Mississippi a National Calamity* (New Orleans: National Flood Commission, 1928), p. 170.

9. 49 stat. 1570. See Hubert Marshall, "The Evaluation of River Basin Development," *Law and Contemporary Problems*, 22 (Spring 1957), p. 241.

10. Raymond Merritt, *Creativity, Conflict & Controversy: A History of the St. Paul District U.S. Army Corps of Engineers* (Washington, D.C.: Government Printing Office, [1980]), p. 75. The St. Paul District history has a complete account of the reservoirs at the headwaters, and the political climate which surrounded them.

11. *Annual Report*, 1940, I, pp. 1193-94.

12. Flood Control Act of 1944. 58 stat. 887.

13. Edward Ackerman and George O. G. Lof, *Technology in American Water Development* (Baltimore, MD: Johns Hopkins Press, 1959), p. 496.

14. Rock Island District News Release, August 21, 1969.

15. *Annual Report*, 1970, II, p. 831.

16. Interview with Ray Stearns, Chief of Planning Branch, September 19, 1973.

17. Information taken from *Rock Island District Flood of April-May, 1951* (Rock Island: Rock Island District, Corps of Engineers, December 1, 1951); *Rock Island District Flood of April-May, 1965, Mississippi River* (Rock Island: U.S. Army Engineer District, Rock Island, June 1, 1966); and from preliminary notes compiled by the Planning Branch for a report on the 1973 flood.